Burden of HIV among female sex workers in low-income and middle-income countries: a systematic review and meta-analysis

Stefan Baral, Chris Beyrer, Kathryn Muessig, Tonia Poteat, Andrea L Wirtz, Michele R Decker, Susan G Sherman, Deanna Kerrigan

Lancet Infect Dis 2012; 12: 538–49

Published Online March 15, 2012 DOI:10.1016/S1473-3099(12)70066-X

See Comment page 500

Johns Hopkins School of Public Health, Baltimore, MD, USA (S Baral MD, Prof C Beyrer MD, K Muessig PhD, T Poteat MPH, A L Wirtz MHS, M R Decker ScD, S G Sherman PhD, D Kerrigan PhD)

Correspondence to: Dr Stefan Baral, Johns Hopkins School of Public Health, E7146, 615 North Wolfe Street, Baltimore, MD, 21205, USA **sbaral@jhsph.edu**

Summary

Background **Female sex workers are a population who are at heightened risk of HIV infection secondary to biological, behavioural, and structural risk factors. However, three decades into the HIV pandemic, understanding of the burden of HIV among these women remains limited. We aimed to assess the burden of HIV in this population compared with that of other women of reproductive age.**

Methods **We searched PubMed, Embase, Global Health, SCOPUS, PsycINFO, Sociological Abstracts, CINAHL (Cumulative Index to Nursing and Allied Health Literature), Web of Science, and POPLine for studies of female sex workers in low-income and middle-income countries published between Jan 1, 2007, and June 25, 2011. Studies of any design that measured the prevalence or incidence of HIV among female sex workers, even if sex workers were not the main focus of the study, were included. Meta-analyses were done with the Mantel-Haenszel method with a random-effects model characterising an odds ratio for the prevalence of HIV among female sex workers compared with that for all women of reproductive age.**

Findings **Of 434 selected articles and surveillance reports, 102 were included in the analyses, representing 99 878 female sex workers in 50 countries. The overall HIV prevalence was 11·8% (95% CI 11·6–12·0) with a pooled odds ratio for HIV infection of 13·5 (95% CI 10·0–18·1) with wide intraregional ranges in the pooled HIV prevalence and odds ratios for HIV infection. In 26 countries with medium and high background HIV prevalence, 30·7% (95% CI 30·2–31·3; 8627 of 28 075) of sex workers were HIV-positive and the odds ratio for infection was 11·6 (95% CI 9·1–14·8).**

Interpretation **Although data characterising HIV risk among female sex workers is scarce, the burden of disease is disproportionately high. These data suggest an urgent need to scale up access to quality HIV prevention programmes. Considerations of the legal and policy environments in which sex workers operate and actions to address the important role of stigma, discrimination, and violence targeting female sex workers is needed.**

Funding **The World Bank, UN Population Fund.**

Introduction

Epidemiological surveillance data have shown declines in the rate of spread of HIV from an estimated 3·1 million (95% CI 3·0–3·3) new infections in 2002 to 2·7 million (95% CI 2·4–2·9) new infections in 2010.[1] UNAIDS estimates that over the past decade, 33 countries—including 22 sub-Saharan African countries—have achieved declines in HIV incidence of more than 25%.[2] These decreases highlight overall advances in the fight against HIV, but might mask sustained or expanding spread among populations who are most at risk including sex workers, men who have sex with men (MSM), and people who use drugs.[2] In much of the world, HIV epidemics are most concentrated in populations who are most at risk,[1] and where HIV epidemics occur in general populations, largely in sub-Saharan Africa, these populations might still have very high disease burdens relative to others.[3–6] Unfortunately, our understanding of the burden of HIV in populations who are most at risk is poor, largely because these populations are poorly represented in national HIV surveillance systems and are hidden and stigmatised in many settings. Female sex workers have been reported to be at high risk for HIV infection in nearly every setting where they have been studied, yet in 2012 we still have limited understanding of the relative burden of HIV in these women.

Sex work—defined here as the exchange of sex for money—and the structure of sex work vary substantially around the world. Those who sell sex might work with or without a controller (eg, pimp, manager) through establishments such as bars, brothels, or saunas, or in more public spaces such as parks, streets, or festivals. Additionally, a growing portion of sex work is arranged through the internet.[7,8] Most sex workers worldwide are women; however, substantial populations of male and transgender sex workers exist in many countries.[9] The dynamics of HIV transmission among male and transgender sex workers could be further complicated by the heightened biological risks of anal intercourse, high prevalence of HIV in some subgroups of MSM, and the large proportion of male and transgender sex workers who report bisexual practices.[9]

HIV infection in female sex workers varies by geographical epidemic typology, structure of sex work, and overlapping nature of HIV-risk behaviours such as injection drug use. Yet the heightened risk for HIV acquisition and transmission among sex workers operates through a similar variety of behavioural, biological or biomedical, and structural risks.[10,11] Behavioural risk factors act at the level of the individual, with sex workers experiencing high-risk sexual exposures through high numbers of sexual partners and high concurrency of these partners. Biologically, the high prevalence of bacterial sexually transmitted infections (STIs) in sex workers[12] and the synergistic relation between HIV and STIs[13] compounds their risks and could lead to complications around reproductive health and childbearing.[14–16] In some settings, protective sexual practices including consistent condom use and HIV testing are higher among sex workers than among women in the general population,[2,7] although these rates remain low in many areas.[17] HIV transmission among sex workers might also be driven, or exacerbated, by the intersection of injection drug use and sex work through increased parenteral exposures from shared injection equipment, sex with more HIV-positive partners, low condom use, and increased risk of other STIs such as syphilis and hepatitis C.[17–19]

Structural risk factors indirectly heighten risk for HIV infection among sex workers by restricting access to preventive health and HIV and STI services and treatment.[7,20,21] Structural factors also include the limiting influences of poverty, discrimination, and gender inequality as well as the damaging effects of physical and sexual violence, stigma, and social exclusion.[22–25] Finally, structural factors such as the organisation and power dynamics of sex work and legal and regulatory policies regarding sex work have also been shown to contribute to sex workers' increased risk of HIV infection by limiting their ability to negotiate safer sex.[26–29] Health enabling environments, including safer work spaces, structural support for condom promotion and distribution, and community empowerment for sex workers have been shown to reduce structural risks for HIV infection.[22,30–34]

Interventions targeting behavioural and structural-level risk factors for HIV among sex workers have proven successful for increasing protective behaviours and decreasing HIV and STI transmission.[35–37] In fact, 44 of 87 countries with available data report that over 80% of sex workers used condoms with their last client.[2] Despite these promising results and increasing number of initiatives, UNAIDS estimates that less than 50% of sex workers worldwide are covered by ongoing HIV prevention programmes.[2] In view of this urgent need for HIV prevention and treatment among sex workers, there is still a lack of crucial information to guide global resource investment because most meta-analyses are limited to a single country or area.[38–41] Systematic reviews and meta-analyses have been undertaken in other populations who are most at risk, including MSM and people who use drugs, to better characterise the relative burden of HIV to background rates.[3,4] To date, however, such a review has not been completed for female sex workers, which is needed to better characterise the relative level of HIV risk among these women and to guide the allocation of resources and content of HIV prevention programmes and policies. The aim of this study is to characterise current burdens of HIV in female sex workers.

Methods

Search strategy and selection criteria

We searched PubMed, EMBASE, Global Health, SCOPUS, PsycINFO, Sociological Abstracts, CINAHL (Cumulative Index to Nursing and Allied Health Literature), Web of Science, and POPLine for studies published between Jan 1, 2007, and June 25, 2011. Articles and citations were downloaded, organised, and reviewed using the QUOSA information management software package (version 8.05) and EndNote (version X4). The search included MeSH terms for HIV or AIDS, and terms associated with sex work (prostitute [MeSH] or "sex work" or "sex work*" or "female sex worker" or "commercial sex worker").

Other data sources included national surveillance system data reports, including AIDS indicator surveys, demographic health surveys, and integrated biobehavioral surveillance studies done by large international non-governmental organisations. Governmental surveillance reports were searched, including those from EuroHIV surveillance, US Centers for Disease Control and Prevention, Australian Surveillance Reports, Public Health Agency of Canada, Pan American Health Organization, and structured government-sponsored surveillance assessments from Asia. Expert researchers were contacted to identify unpublished or in-press data not identified through other search methods, although data were only included if the studies met all inclusion criteria.

Studies of any design were included that measured the prevalence or incidence of HIV among female sex workers, even if sex workers were not the main focus of the study. Studies were accepted if clear descriptions of HIV testing methods were included such as laboratory-derived HIV status with biological samples from blood, urine, or oral specimens. Only studies from countries defined as low income or middle income on the basis of The World Bank Atlas Method including all countries with a gross national income of US$12 275 per head or less were included. To be included, clear descriptions of the sampling, HIV testing, and analytical methods were required with sources including peer-reviewed journals and non-peer-reviewed publications meeting other criteria with online availability in the public domain. Studies published in English, French, Spanish, or Portuguese were included.

Studies were excluded if the sample size of female sex workers was less than 50 in a study including other populations or if the total sample size was less than 50 in studies that only included female sex workers. Additionally, studies that only included self-reported HIV status rather than biological testing were excluded from the analysis.

Screening and data extraction

All publications were originally screened by two independent reviewers (KM and TP) to include those that potentially included data about HIV prevalence, were not included in duplicate, and originated from low-income or middle-income countries. If either author classed a publication as relevant, the abstract was reviewed. Two independent reviewers (KM and TP) examined the abstracts of the remaining articles and retained those that either clearly met the inclusion criteria or for whom the full text of the article had to be reviewed before a final decision about inclusion could be made. If either author classed an article as relevant, a full-text copy was obtained. Review of these full-text articles was done by two independent reviewers (KM and TP). Subsequently, data were extracted by two trained coders with standardised data extraction forms that included details about study design, methods of recruitment, location, sample size, period of study, reported HIV prevalence, incidence, or both among female sex workers, HIV prevalence among comparison groups (if provided), and 95% CIs. Coders showed high agreement (90%), with discrepancies resolved through referral to a third senior study team member (SB). Methodological quality of each study was determined via assessment of sampling and recruitment methods, response rates, data reporting, and information about unmeasured biases and confounders.

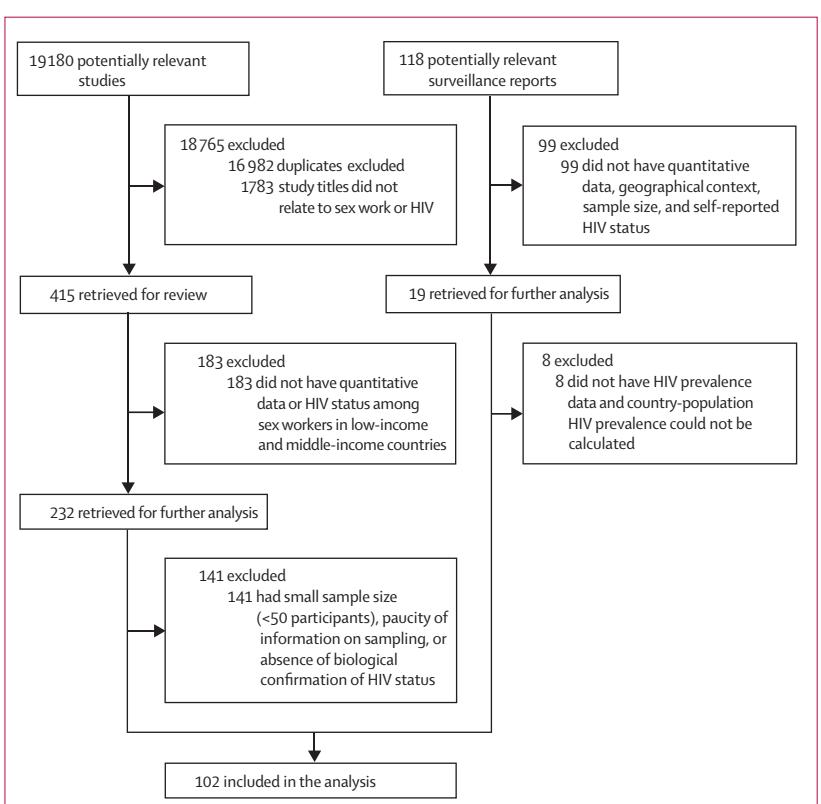

Figure 1: **Flow chart of included studies**

Statistical analysis

The prevalence for all reproductive age women in the general population was calculated using 2009 data from the UNAIDS report to assess the number of women, aged 15 years or older, living with HIV in each country as the numerator. The denominator used to measure HIV prevalence among women in the general population was assessed in two ways: data from the US Census Bureau International Division was used to assess the total number of women who were aged 15 years or older and also the total number of women of reproductive age, or those between the ages of 15 and 49 years. The meta-analysis represents the increased odds of being HIV seropositive for female sex workers compared with all women; it was completed with the Mantel-Haenszel method with a random-effects model with the assumption that the HIV prevalence in one country was independent of the HIV prevalence in other countries. A standard correction of 0·5 was added to all zero cells with STATA (version 11). Heterogeneity testing was done with the DerSimonian and Laird's Q test.[34] The data are presented in the form of forest plots including the odds ratio, its 95% CI, and the relative weight of any particular study in estimating the summary odds ratio for all countries.

Meta-analyses of subgroups of countries by prevalence level and region were also done. The following categorisation scheme classed the HIV prevalence among women of reproductive age or those aged 15–49 years as very low prevalence (<0·5% living with HIV), low prevalence (0·5–1·0%), medium prevalence (1·1–5·0%), and high prevalence (>5%).[42] A similar approach was used for systematic review of MSM in low-income and middle-income countries.[4]

As a sensitivity analysis, we used the two different aforementioned calculated background rates. No significant difference was detected between estimates calculated with these two methods. However, since women older than 49 years of age contribute relatively few infections in most low-income and middle-income countries, use of the background rate calculated with the numerator for women older than 15 years of age and the denominator for those aged between 15 and 49 years was deemed to be a more conservative approach. As of 2009, UNAIDS did not produce estimates of the number of people living with HIV in Afghanistan, Laos, and Albania and thus these countries were excluded from the meta-analysis.

To quantify the number of infections among women of reproductive age attributable to infections among female sex workers, estimates of HIV prevalence among female sex workers by country and region characterised primarily by Vandepitte and colleagues[42] were used unless more recent data were available.[43–47] When an estimate of the total number of female sex workers by country was available this estimate was used; otherwise a regional estimate was used. In each case, the lowest estimate in the range provided was used to be conservative. To complete the meta-analysis, we used estimates of the proportion of HIV cases among women attributable to female sex workers, by country.

Role of the funding source

The sponsor of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

Our search criteria identified 19180 citations, of which

	Sample size	HIV prevalence among female sex workers (95% CI)	HIV prevalence among female population	Odds ratio (95% CI)	Prevalence level*	% HIV infections among female sex workers
Asia						
Afghanistan[48]	544	0·2% (0–0·5)	NA	NA	NA	NA
Bangladesh[49]	9383	0·2% (0·1–0·3)	0·00%	47·8 (30·8–74·3)	Very low	9·5%
Cambodia[50]	160	23·1% (16·6–29·7)	0·86%	34·8 (24·1–50·3)	Low	8·1%
China[51–62]	18773	3·0% (2·8–3·3)	0·06%	50·0 (46·0–54·4)	Very low	48·6%
India[63–69]	13386	13·7% (13·1–14·3)	0·29%	54·3 (51·7–57·0)	Very low	23·5%
Indonesia[70,71]	7482	4·9% (4·4–5·4)	0·14%	38·0 (34·2–42·2)	Very low	14·5%
Laos[72]	1422	0·5% (0·1–0·9)	NA	NA	NA	NA
Malaysia[73]	552	10·7% (8·1–13·3)	0·15%	81·2 (62·0–106·5)	Very low	65·4%
Mongolia[74–76]	931	0·0% (0·0–0·0)	0·02%	2·4 (0·2–39·1)	Very low	0·0%
Nepal[77–79]	1687	8·3% (7·0–9·6)	0·26%	35·0 (29·4–41·6)	Very low	64·4%
Pakistan[80–82]	5999	0·1% (0·0–0·1)	0·06%	0·8 (0·3–2·5)	Very low	0·3%
Papua New Guinea[83,84]	205	16·6% (11·5–21·7)	1·20%	16·1 (10·1–25·7)	Medium	5·6%
Thailand[85]	319	11·9% (8·4–15·5)	1·15%	11·6 (8·3–16·3)	Medium	2·1%
Vietnam[86–88]	3381	6·5% (5·7–7·3)	0·32%	22·0 (19·2–25·2)	Very low	4·1%
Eastern Europe						
Albania[89]	92	1·1% (0·0–3·2)	NA	NA	NA	NA
Estonia[90,91]	433	8·1% (5·5–10·7)	0·95%	9·1 (6·5–12·9)	Low	9·3%
Georgia[92]	234	0·4% (0·0–1·3)	0·13%	3·3 (0·5–23·8)	Very low	2·3%
Ukraine[93]	2278	12·9% (11·5–14·3)	1·46%	10·0 (8·9–11·3)	Medium	3·6%
Latin America and the Caribbean						
Argentina[94]	625	3·2% (1·8–4·6)	0·34%	9·6 (6·1–15·0)	Very low	1·9%
Brazil[95]	90	6·7% (1·5–11·8)	0·47%	15·3 (6·7–34·9)	Very low	10·0%
Chile[96]	626	0·0% (0·0–0·0)	0·27%	0·3 (0·02–4·6)	Very low	0·0%
Guatemala[97,98]	1110	4·4% (3·2–5·6)	0·58%	7·9 (5·9–10·5)	Low	4·6%
El Salvador[98]	484	3·3% (1·7–4·9)	0·67%	5·1 (3·1–8·3)	Low	3·0%
Guyana[99]	450	27·6% (23·4–31·7)	1·48%	25·3 (20·5–31·2)	Medium	11·2%
Honduras[98]	493	9·7% (7·1–12·4)	0·59%	18·1 (13·5–24·5)	Low	9·9%
Jamaica[100]	433	8·8% (6·1–11·4)	1·31%	7·3 (5·2–10·1)	Medium	4·0%
Mexico[101–107]	4743	6·2% (5·6–6·9)	0·19%	35·0 (31·1–39·4)	Very low	19·8%
Nicaragua[98]	460	2·2% (0·8–3·5)	0·13%	16·8 (8·9–31·4)	Very low	9·9%
Paraguay[108]	723	2·8% (1·6–4·0)	0·22%	12·8 (8·2–19·9)	Very low	7·5%
Middle East and north Africa						
Egypt[109]	118	0·8% (0·0–2·5)	0·01%	73·2 (10·2–524·1)	Very low	36·3%
Lebanon[110]	95	0·0% (0·0–0·0)	0·10%	5·4 (0·34–87·5)	Very low	0·0%
Somalia[111]	237	5·5% (2·6–8·4)	0·67%	8·6 (4·9–15·0)	Low	29·4%
Sudan[112]	321	0·9% (0·0–2·0)	1·32%	0·7 (0·2–2·2)	Medium	2·6%
Tunisia[113]	188	0·0% (0·0–0·0)	0·03%	8·0 (0·5–128·7)	Very low	0·0%

(Continues on next page)

	Sample size	HIV prevalence among female sex workers (95% CI)	HIV prevalence among female population	Odds ratio (95% CI)	Prevalence level*	% HIV infections among female sex workers
(Continued from previous page)						
Sub-Saharan Africa						
Benin[114,115]	792	40·9% (37·5–44·3)	1·54%	44·2 (38·3–51·0)	Medium	15·9%
Cameroon[116]	1005	29·5% (26·6–32·3)	7·00%	5·5 (4·8–6·3)	Medium	5·1%
Comoros[117]	153	0·7% (0·0–1·9)	0·06%	11·3 (1·6–81·7)	Very low	27·0%
Democratic Republic of Congo[118–121]	1066	9·4% (7·6–11·1)	1·60%	6·4 (5·2–7·8)	Medium	3·5%
Guinea[122]	937	36·7% (33·6–39·8)	1·72%	33·1 (29·0–37·8)	Medium	2·5%
Kenya[123–131]	7544	45·1% (44·0–46·2)	7·72%	9·8 (9·4–10·3)	High	32·2%
Madagascar[132]	100	0·0% (0·0–0·0)	0·15%	3·4 (0·2–54·7)	Very low	0·0%
Malawi[133]	273	70·7% (65·3–76·1)	13·33%	15·7 (12·1–20·4)	High	12·7%
Mauritius[134]	291	32·6% (27·3–38·0)	0·71%	67·4 (52·6–86·4)	Low	9·1%
Nigeria[135,136]	3477	33·7% (32·1–35·3)	4·54%	10·7 (10·0–11·5)	Medium	4·5%
Rwanda[137]	800	24·0% (21·0–27·0)	3·32%	9·2 (7·8–10·8)	Medium	26·0%
Senegal[138,139]	1656	19·9% (18·0–21·9)	1·04%	23·7 (21·0–26·7)	Medium	11·5%
South Africa[140]	775	59·6% (56·2–63·1)	25·32%	4·4 (3·8–5·0)	High	5·7%
Togo[141]	1311	36·2% (33·6–38·8)	4·20%	12·7 (11·4–14·2)	Medium	76·7%
Uganda[142]	1027	37·2% (34·2–40·2)	8·51%	6·4 (5·6–7·2)	High	15·7%
Zimbabwe[143]	214	61·2% (54·7–67·7)	21·42%	5·8 (4·4–7·6)	High	6·9%
Pooled estimate	99878	11·8% (11·6–12·0)	..	13·5 (10·0–18·1)†	..	..

NA=not applicable. *Prevalence level: very low (<0·5%), low (0·5–1·0%), medium (1·1–5·0%), high (>5·0%). †Heterogeneity χ^2=7023·11 (degrees of freedom=46); I^2=99·3%; test of odds ratio=1, Z=17·27, p=0·0001.

Table 1: **Meta-analyses of aggregate country data comparing HIV prevalence among female sex workers and women of reproductive age in low-income and middle-income countries, 2007–11**

	Number of countries	Sample size of sex workers with HIV	Sample size of sex workers	Pooled HIV prevalence (95% CI)	Background prevalence	Pooled odds ratios (95% CI)
Region						
Asia	14	3323	64 224	5·2% (5·0–5·3)	0·18%	29·2 (22·2–38·4)
Eastern Europe	4	331	3037	10·9% (9·8–12·0)	0·20%	NA
Latin America and the Caribbean	11	627	10 237	6·1% (5·7–6·6)	0·38%	12·0 (7·3–19·7)
Middle East and north Africa	5	17	959	1·7% (0·9–2·6)	0·43%	NA
Sub-Saharan Africa	16	7899	21 421	36·9% (36·2–37·5)	7·42%	12·4 (8·9–17·2)
Prevalence level						
Very low or low*	21	3561	69 729	5·1% (4·9–5·3)	0·17%	24·5 (19·1–31·3)
Medium or high†	26	8627	28 075	30·7% (30·2–31·3)	5·47%	11·6 (9·1–14·8)
Total‡	50	12 197	99 878	11·8% (11·6–12·0)	..	13·5 (10·0–18·1)

*Very low (<0·5%), low (0·5–1·0%). †Medium (1·1–5·0%), high (>5·0%). ‡Meta-analysis of prevalence does not include Afghanistan, Laos, and Albania.

Table 2: **Subgroup meta-analysis of pooled odds ratios for HIV infection among female sex workers, by region and prevalence level**

2240 were unique records (figure 1). Of 434 selected articles and surveillance reports, data from 102 met inclusion criteria. These studies included 91 articles and 11 surveillance reports representing 99 878 female sex workers in 50 countries: 14 countries in Asia, four in the eastern Europe, 11 in Latin America and the Caribbean, five in the Middle East and north Africa, and 16 countries in sub-Saharan Africa (figure 1, table 1).

The overall HIV prevalence among female sex workers in all regions was 11·8% (95% CI 11·6–12·0; table 1) with notable variation by region, reflective of background rates of HIV. The highest prevalence of HIV was in sub-Saharan Africa, followed by eastern Europe, Latin America and the Caribbean, and Asia; the lowest rate was in the Middle East and north Africa (table 2).

The overall estimate for the odds ratio for a female sex worker to be living with HIV compared with all women of reproductive age in low-income and middle-income

countries was 13·5 (95% CI 10·0–18·1; table 2). The highest pooled odds ratio for HIV infection among sex workers was seen in Asia, followed by sub-Saharan Africa. The lowest odds ratio was seen in Latin America and the Caribbean (table 2). Sex workers from countries with very low or low HIV prevalence had higher odds of infection than did sex workers from countries with medium or high HIV prevalence among all women (figures 2, 3).

Sensitivity analyses compared whether there would be a difference in odds ratio when comparing the HIV prevalence rates among female sex workers with that of all women, including sex workers, or comparing them with women who do not sell sex. Globally, no substantially different magnitude in the relation between these two scenarios was seen. However, in China, India, Malaysia, Egypt, and Rwanda a substantial increase was reported in the odds ratio of HIV infection among female sex workers when compared with women who do not sell sex rather than all women of reproductive age. In each of these countries, more than 20% of prevalent HIV infections among women were attributable to female sex workers (table 1). To be conservative, the odds ratios we report refer to the comparison of female sex workers with that of all women of reproductive age, including female sex workers.

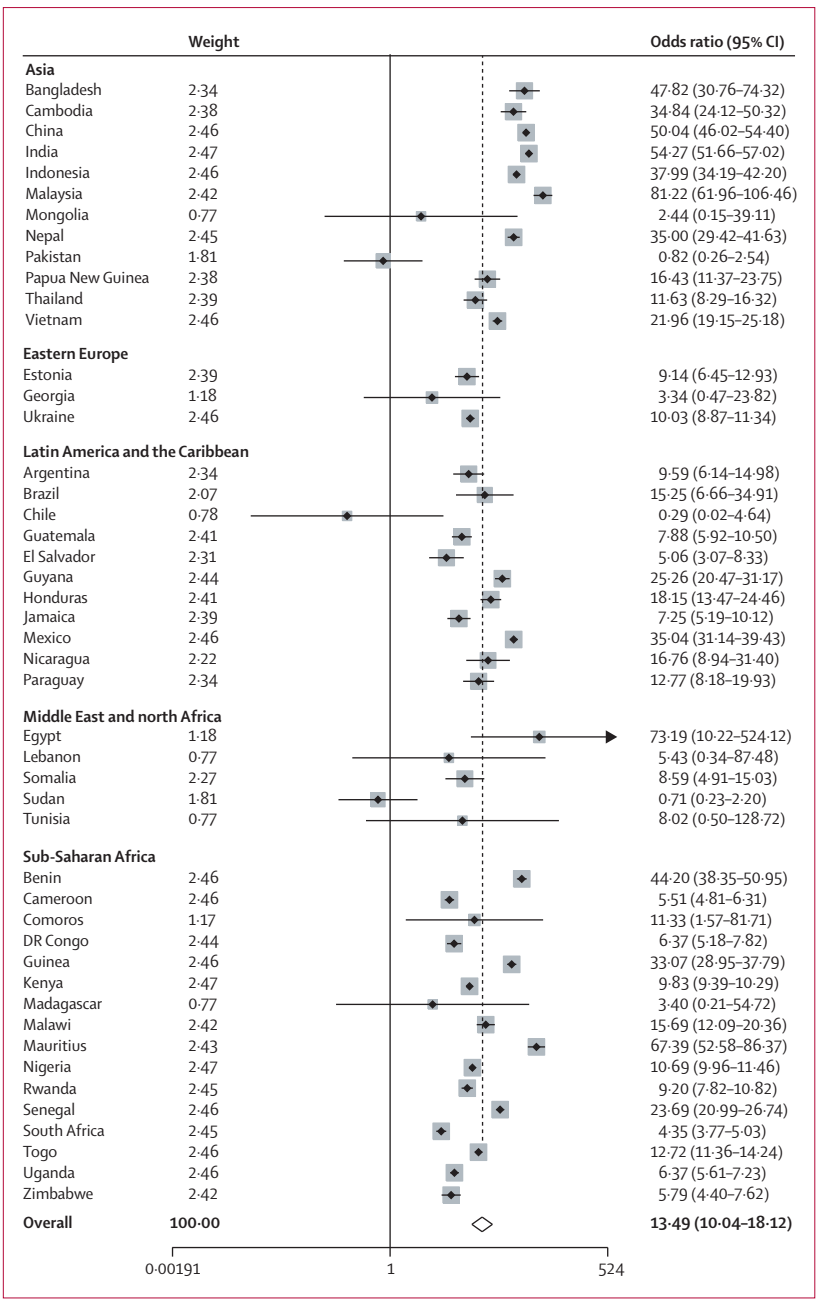

Figure 2: **Forest plot showing meta-analysis of risk of HIV infection among female sex workers compared with women aged 15–49 years in low-income and middle-income countries, 2007–11**

Discussion

We identified consistent evidence of substantially higher levels of HIV among female sex workers compared with all women of reproductive age in low-income and middle-income countries in all regions with data. Although female sex workers have long been understood to be a key affected population, the scope and breadth of their disproportionate risk for HIV infection had to date not been systematically documented.

The largest sample size was available from Asia (table 1), where we reported the highest relative burden of disease (table 2). While some countries such as Thailand showed a trend towards higher prevalence in the 1990s, surveillance data have shown an increasingly concentrated HIV epidemic in populations who are most at risk.[144] Responses such as the 100% condom campaign have been heralded as successes, though HIV prevalence remains higher than 10% among female sex workers and the odds of infection remain ten-times higher than that of all Thai women, suggesting the need for complementary HIV prevention strategies including biomedical approaches, such as oral or topical chemoprophylaxis or treatment as prevention, and structural approaches.[145,146] In India, the Avahan and Sonagachi combination HIV prevention programmes have had many targets such as addressing structural issues, including community empowerment, campaigns to address stigma, and structural policy support, as well as targeting high-risk sexual practices by increasing condom use during sex.[147,148] Both programmes have been deemed to be successes and are being scaled up across the country. When reviewing the data from the past 5 years, female sex workers still carry more than a 50-times increased odds of HIV infection in India. Since HIV prevalence is a lagging indicator of prevention success, time is needed to reveal the benefit of these programmes in terms of the absolute burden of HIV among female sex workers in India. Nonetheless, the disproportionate burden of HIV among these sex workers, even in settings where progressive

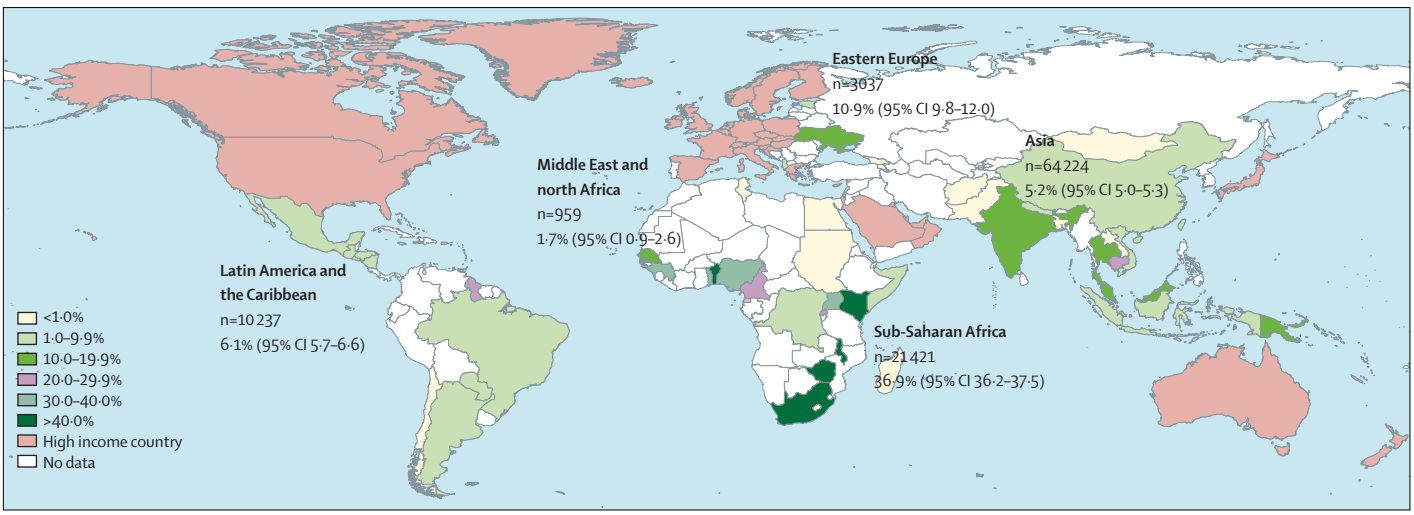

Figure 3: **Map of HIV prevalence among female sex workers in low-income and middle-income countries including data from 2007–11, categorised by HIV prevalence and pooled HIV prevalence estimates by region**

programmes exist, emphasises the need to increase coverage by increasing scale of prevention programmes and decreasing barriers to access.

HIV in Latin America and the Caribbean has remained a disease mostly concentrated among populations who are most at risk since the beginning of the epidemic.[149] With low background prevalence and early recognition of the high risk among sex workers in Latin America and the Caribbean, HIV prevalence has a limited magnitude among sex workers in the region. Brazil famously declined USAID funding over the need to sign the "Prostitution Pledge", which was mandated as part of the President's Emergency Plan for AIDS Relief (PEPFAR) in 2003, and would have limited the ability to do comprehensive surveillance and service provision for sex workers.[150,151] Consequently, Brazil has continued to invest in HIV prevention for sex workers throughout the country.[152] In these analyses, Guyana was an anomaly in that female sex workers had more than 25-times increased odds of HIV infection. These analyses show that the HIV epidemic among female sex workers in Latin American and the Caribbean is not over, because these women have more than ten-times increased odds of having HIV than other women.

Sufficient data were not available to warrant meta-analyses of HIV prevalence among female sex workers in eastern Europe and the Middle East and north Africa. Most data in eastern Europe was derived from Ukraine, and in the Middle East and north Africa the combined data from the studies represented less than a thousand sex workers. The studies that have been done in these regions show that sex workers exist and that prevalence of HIV, although low in these settings, is concentrated among these women. In view of the importance of parenteral transmission of HIV through injection drug use in eastern Europe, characterisation of the synergies between epidemics of injection drug use and injection drug use among female sex workers in this region is important to guide prevention.

While wide variation in the prevalence of HIV exists across western, eastern, and southern Africa, the prevalence of HIV among female sex workers is high in each of these regions (table 1). Variation in the relative odds of infection among these women seems to be largely attributable to high background rates of HIV prevalence among all adults in hyperendemic zones, especially in southern regions of Africa. According to UNAIDS criteria, these countries have generalised epidemics because the HIV prevalence among women of reproductive age (as measured in antenatal clinics) is higher than 1%.[153] Application of the system used by Stover and colleagues[154] showed that these prevalence levels correspond to medium-prevalence and high-prevalence HIV epidemics. Overall, even in generalised epidemics in sub-Saharan Africa, female sex workers have more than 12-times increased odds of living with HIV as compared with all women. Similarly, in other medium and high HIV-prevalence settings, or generalised HIV epidemics, the odds ratio for HIV infection was high. These findings counter the notion that female sex workers play a less relevant part in the transmission of HIV in generalised epidemics.

The largest body of data about HIV prevalence among female sex workers in Africa was available from Kenya where in 2010, the Kenyan National AIDS and STI Control Program (NASCOP) developed a set of National Guidelines for HIV and STI Programmes for sex workers.[155] These guidelines were developed in response to the Kenya National HIV Strategic Plan (KNASP III) 2009–13, which identified that female sex workers were a population who are most at risk and that barriers existed that limited their access to health and social services

because some of their work is both criminalised and stigmatised by society.[156] Encouragingly, incidence rates of HIV have been decreasing among some groups of female sex workers in Kenya, signalling decreasing HIV incidence in the general population.

In Pakistan, Chile, and Sudan the odds ratio for HIV associated with sex work suggested a trend towards this practice being protective, though this trend was not significant in any of these countries. Moreover, in Mongolia and Madagascar, the odds ratio for HIV among female sex workers was also not significantly increased. These results are likely to have some combination of truth and artefact. Non-probability samples of female sex workers could have underestimated the actual HIV prevalence in the population. However, in each of these countries except for Sudan, most prevalent HIV infections in 2009 were among men with risk factors including same-sex practices and injecting drug use.[2–4,6] In Sudan, competing risk factors exist for HIV including migration and rape, which might, in part, account for these results.[157]

Our study had several limitations. The focus on data from the past 5 years with an inclusion criterion of January, 2007, excluded data from many countries. While this exclusion represents a limitation, the aim of this study was to characterise current burdens of HIV in female sex workers. Any pooling of data comes at the risk of masking intracountry and intercountry variations in the risk status, including practices and HIV prevalence, and variations in the social contexts of female sex workers. Such masking in the variation of risk status is relevant in India and China, which have wide geographical variations in HIV prevalence and risk factors for HIV infection. Furthermore, these estimates are of limited generalisability since most studies were done in urban settings; female sex workers working in more rural settings, border areas, and truck stops were under-represented. The pooled estimates also mask differences between various contexts in which sex work is practised including establishment-based versus non-establishment-based sex work or additional risk factors among sex workers including injecting drug use and migration. There was significant heterogeneity of the HIV-prevalence results included in the meta-analysis, because these studies were from different populations of female sex workers in different countries. To account for this difference, a random-effects model was used for the meta-analysis.

The comparison of HIV prevalence rates among female sex workers and all women was conservative since HIV infections were included in the estimates provided by UNAIDS for all women of reproductive age. To address this issue, a sensitivity analysis was done to account for prevalent infections among women of reproductive age attributable to female sex workers, after which we undertook the meta-analysis. The size of the global pooled estimate did not change though it did change in certain countries where a high proportion of HIV in women is attributable to sex work. While the pooled analysis is limited in relation to the heterogeneity estimates by country, it does show the continued disease burden among female sex workers, and their continued need for services. A recent report on the investment framework for the global response to HIV/AIDS suggested that current allocation of resources for sex workers was adequate.[158] This analysis, contextualised by evidence that female sex workers living with HIV have more sexual partners than other women of reproductive age living with HIV and have higher rates of STIs facilitating HIV transmission, suggests that more resources are needed to address these subepidemics.[94,159–161]

This report shows that 50 of 145 low-income and middle-income countries have published data for the past 5 years that include biological assessments of HIV prevalence among female sex workers (figure 3).[162] In other words, about two-thirds of low-income and middle-income countries do not have a current estimate of the burden of HIV in this population. Possible explanations for these gaps in the data include social stigma, criminalisation of sex work, and the "Prostitution Pledge", which conflated the issue of sex work and human trafficking and substantially reduced research funding and investigator interest in this area.[151]

These findings suggest an urgent need to scale up access to quality HIV-prevention programming and services among female sex workers because of their heightened burden of disease and likelihood of onward transmission through high numbers of sexual partners as clients. In view of the high burden of HIV among female sex workers and recent biomedical advances related to treatment as prevention, improvement of linkages to antiretroviral treatment, and retention in care, ongoing prevention for sex workers already living with HIV is crucial.[163] The substantially increased odds of living with HIV among sex workers merits continued research regarding the role of not only behavioural but also structural factors associated with HIV in this population. Considerations of the legal and policy environments in which sex workers operate, and the important role of stigma, discrimination, and violence targeting female sex workers globally will be required to reduce the disproportionate disease burden among these women.

Contributors

SB, DK, and CB designed the study. SB and TP developed and implemented the search protocol. KM, AW, and TP abstracted data with SB acting as a tiebreaker at all stages. ALW developed the global prevalence map. MRD and SGS provided technical support at all stages. All authors wrote the report.

Conflicts of interests

We declare that we have no conflicts of interest.

Acknowledgments

We thank female sex workers who have participated in epidemiological studies and surveillance programmes to assess the burden of HIV; Jenny Butler for her tireless leadership and guidance for this work; Robert Oelrichs, Iris Semini, and Ndella Njie for guidance and technical support in the interpretation of these data; several organisations and

people at the Network of Sex Work Projects, including Ruth Morgan Thomas, who provided important support in the development of this project; and Madeleine Schlefer for her support in reviewing and abstracting large bodies of data. This work was supported by the International Bank for Reconstruction and Development and The World Bank. The findings, interpretations, and conclusions expressed in this publication do not necessarily reflect the views of the executive directors of The World Bank or the governments they represent. The boundaries, colours, denominations, and other information shown on any map in this work do not imply any judgment on the part of The World Bank concerning the legal status of any territory or the endorsement or acceptance of such boundaries.

References

1 UNAIDS. Global HIV/AIDS Response: epidemic update and health sector progress towards universal access. Geneva: United Nations, 2011.
2 UNAIDS. UNAIDS report on the global AIDS epidemic: 2010. Geneva: United Nations, 2010.
3 Mathers BM, Degenhardt L, Ali H, et al. HIV prevention, treatment, and care services for people who inject drugs: a systematic review of global, regional, and national coverage. *Lancet* 2010; **375:** 1014–28.
4 Baral S, Sifakis F, Cleghorn F, Beyrer C. Elevated risk for HIV infection among men who have sex with men in low- and middle-income countries 2000-2006: a systematic review. *PLoS Med* 2007; **4:** e339.
5 Beyrer C, Wirtz A, Walker D, Johns B, Sifakis F, Baral S. The global HIV epidemics among men who have sex with men: epidemiology, prevention, access to care and human rights. Washington DC: World Bank Publications, 2011.
6 Beyrer C, Baral SD, Walker D, Wirtz AL, Johns B, Sifakis F. The expanding epidemics of HIV type 1 among men who have sex with men in low- and middle-income countries: diversity and consistency. *Epidemiol Rev* 2010; **32:** 137–51.
7 UNAIDS. UNAIDS guidance note on HIV and sex work. Geneva: World Health Organization, 2009.
8 Harcourt C, Donovan B. The many faces of sex work. *Sex Transm Infect* 2005; **81:** 201–06.
9 Aggleton P, ed. Men who sell sex: international perspectives on male prostitution and HIV/AIDS. Philadelphia: Temple University Press, 1999.
10 Watts C, Zimmerman C, Foss AM, Hossain M, Cox A, Vickerman P. Remodelling core group theory: the role of sustaining populations in HIV transmission. *Sex Transm Infect* 2010; **86** (suppl 3)**:** iii85–92.
11 Kilmarx PH. Global epidemiology of HIV. *Curr Opin HIV AIDS* 2009; **4:** 240–46.
12 Cwikel JG, Lazer T, Press F, Lazer S. Sexually transmissible infections among female sex workers: an international review with an emphasis on hard-to-access populations. *Sex Health* 2008; **5:** 9–16.
13 Cohen MS. Sexually transmitted diseases enhance HIV transmission: no longer a hypothesis. *Lancet* 1998; **351** (suppl 3)**:** 5–7.
14 Chacham AS, Diniz SG, Maia MB, Galati AF, Mirim LA. Sexual and reproductive health needs of sex workers: two feminist projects in Brazil. *Reprod Health Matters* 2007; **15:** 108–18.
15 Decker MR, McCauley HL, Phuengsamran D, Janyam S, Silverman JG. Sex trafficking, sexual risk, sexually transmitted infection and reproductive health among female sex workers in Thailand. *J Epidemiol Community Health* 2011; **65:** 334–39.
16 Swain SN, Saggurti N, Battala M, Verma RK, Jain AK. Experience of violence and adverse reproductive health outcomes, HIV risks among mobile female sex workers in India. *BMC Public Health* 2011; **11:** 357.
17 Medhi GK, Mahanta J, Paranjape RS, Adhikary R, Laskar N, Ngully P. Factors associated with HIV among female sex workers in a high HIV prevalent state of India. *AIDS Care* 2012; **24:** 369–76.
18 Strathdee SA, Philbin MM, Semple SJ, Pu M, Orozovich P, Martinez G, et al. Correlates of injection drug use among female sex workers in two Mexico–U.S. border cities. *Drug Alcohol Depend* 2008; **92:** 132–40.
19 Tuan NA, Fylkesnes K, Thang BD, et al. Human immunodeficiency virus (HIV) infection patterns and risk behaviours in different population groups and provinces in Viet Nam. *Bull World Health Organ* 2007; **85:** 35–41.
20 Chakrapani V, Newman PA, Shunmugam M, Kurian AK, Dubrow R. Barriers to free antiretroviral treatment access for female sex workers in Chennai, India. *AIDS Patient Care STDs* 2009; **23:** 973–80.
21 Rosenheck R, Ngilangwa D, Manongi R, Kapiga S. Treatment-seeking behavior for sexually transmitted infections in a high-risk population. *AIDS Care* 2010; **22:** 1350–58.
22 Argento E, Reza-Paul S, Lorway R, et al. Confronting structural violence in sex work: lessons from a community-led HIV prevention project in Mysore, India. *AIDS Care* 2011; **23:** 69–74.
23 Simic M, Rhodes T. Violence, dignity and HIV vulnerability: street sex work in Serbia. *Sociol Health Illn* 2009; **31:** 1–16.
24 Onyeneho NG. HIV/AIDS risk factors and economic empowerment needs of female sex workers in Enugu Urban, Nigeria. *Tanzania J Health Res* 2009; **11:** 126–35.
25 Udoh IA, Mantell JE, Sandfort T, Eighmy MA. Potential pathways to HIV/AIDS transmission in the Niger Delta of Nigeria: poverty, migration and commercial sex. *AIDS Care* 2009; **21:** 567–74.
26 Nhurod P, Bollen LJ, Smutraprapoot P, et al. Access to HIV testing for sex workers in Bangkok, Thailand: a high prevalence of HIV among street-based sex workers. *Southeast Asian J Trop Med Public Health* 2010; **41:** 153–62.
27 Yang C, Latkin C, Luan R, Nelson K. Condom use with female sex workers among male clients in Sichuan Province, China: the role of interpersonal and venue-level factors. *Bull NY Acad Med* 2010; **87:** 292–303.
28 Sirotin N, Strathdee SA, Lozada R, et al. Effects of government registration on unprotected sex amongst female sex workers in Tijuana; Mexico. *Int J Drug Policy* 2010; **21:** 466–70.
29 Erausquin JT, Reed E, Blankenship KM. Police-related experiences and hiv risk among female sex workers in Andhra Pradesh, India. *J Infect Dis* 2011; **204** (suppl 5)**:** S1223–28.
30 International HIV/AIDS Alliance CHaAAG. Enabling legal environments for effective HIV responses: a leadership challenge for the Commonwealth. 2010. http://www.aidsalliance.org/includes/Publication/Enabling-legal-environments-for-effective-HIV-responses.pdf (accessed March 6, 2012).
31 Reza-Paul S, Beattie T, Syed HU, et al. Declines in risk behaviour and sexually transmitted infection prevalence following a community-led HIV preventive intervention among female sex workers in Mysore, India. *AIDS* 2008; **22** (suppl 5)**:** S91–100.
32 Shannon K, Kerr T, Allinott S, Chettiar J, Shoveller J, Tyndall MW. Social and structural violence and power relations in mitigating HIV risk of drug-using women in survival sex work. *Soc Sci Med* 2008; **66:** 911–21.
33 Kerrigan D, Ellen JM, Moreno L, et al. Environmental-structural factors significantly associated with consistent condom use among female sex workers in the Dominican Republic. *AIDS* 2003; **17:** 415–23.
34 Sweat M, Kerrigan D, Moreno L, et al. Cost-effectiveness of environmental-structural communication interventions for HIV prevention in the female sex industry in the Dominican Republic. *J Health Commun* 2006; **11** (suppl 2)**:** 123–42.
35 Ghose T, Swendeman D, George S, Chowdhury D. Mobilizing collective identity to reduce HIV risk among sex workers in Sonagachi, India: the boundaries, consciousness, negotiation framework. *Soc Sci Med* 2008; **67:** 311–20.
36 Gibney L, DiClemente R, Vermund S, eds. Preventing HIV in developing countries: biomedical and behavioral approaches. New York: Kluwer Academic Publishers, 2002.
37 Odek WO, Busza J, Morris CN, Cleland J, Ngugi EN, Ferguson AG. Effects of micro-enterprise services on HIV risk behaviour among female sex workers in Kenya's urban slums. *AIDS Behav* 2009; **13:** 449–61.
38 Halperin DT, de Moya EA, Perez-Then E, Pappas G, Garcia Calleja JM. Understanding the HIV epidemic in the Dominican Republic: a prevention success story in the Caribbean? *J Acquir Immune Defic Syndr* 2009; **51** (suppl 1)**:** 52–59.
39 Malta M, Magnanini MM, Mello MB, Pascom AR, Linhares Y, Bastos FI. HIV prevalence among female sex workers, drug users and men who have sex with men in Brazil: a systematic review and meta-analysis. *BMC Public Health* 2010; **10:** 317.
40 Scorgie F, Chersich MF, Ntaganira I, Gerbase A, Lule F, Lo YR. Socio-demographic characteristics and behavioral risk factors of female sex

workers in sub-saharan africa: a systematic review. *AIDS Behav* 2011; published online July 14. DOI:10.1007/s10461-011-9985-z.

41 Poon AN, Li Z, Wang N, Hong Y. Review of HIV and other sexually transmitted infections among female sex workers in China. *AIDS Care* 2011; **23** (suppl 1)**:** 5–25.

42 Vandepitte J, Lyerla R, Dallabetta G, Crabbe F, Alary M, Buve A. Estimates of the number of female sex workers in different regions of the world. *Sex Transm Infect* 2006; **82** (suppl 3)**:** iii18–25.

43 Emmanuel F, Blanchard J, Zaheer HA, Reza T, Holte-Mckenzie M. The HIV/AIDS surveillance project mapping approach: an innovative approach for mapping and size estimation for groups at a higher risk of HIV in Pakistan. *AIDS* 2010; **24** (suppl 2)**:** S77–S84.

44 Vuylsteke B, Vandenhoudt H, Langat L, et al. Capture recapture for estimating the size of the female sex worker population in three cities in Cote d'Ivoire and in Kisumu, western Kenya. *Trop Med Int Health* 2010; **15:** 1537–43.

45 Ahoyo AB, Alary M, Meda H, et al. Female sex workers in Benin, 2002. Behavioural survey and HIV and other STI screening. *Cahiers Sante* 2007; **17:** 143–51.

46 Zhang D, Wang L, Lv F, et al. Advantages and challenges of using census and multiplier methods to estimate the number of female sex workers in a Chinese city. *AIDS Care* 2007; **19:** 17–19.

47 Talbott JR. Size matters: the number of prostitutes and the global HIV/AIDS pandemic. *PLOS One* 2007; **2:** e543.

48 Todd CS, Nasir A, Stanekzai MR, et al. HIV, hepatitis B, and hepatitis C prevalence and associated risk behaviors among female sex workers in three Afghan cities. (Special Issue: Progress in HIV research in the Middle East and North Africa: new study methods, results, and implications for prevention and care). *AIDS* 2010; **24** (suppl 2)**:** S69–S75.

49 National AIDS/STD Programme Bangladesh. National HIV Serological Surveillance, Bangladesh: 8th Round Technical Report. Dhaka: Government of the People's Republic of Bangladesh, 2008.

50 Couture MC, Sansothy N, Sapphon V, et al. Young women engaged in sex work in Phnom Penh, Cambodia, have high incidence of HIV and sexually transmitted infections, and amphetamine-type stimulant use: New challenges to HIV prevention and risk. *Sex Transm Dis* 2011; **38:** 33–39.

51 Xu J, Brown K, Ding G, et al. Factors associated with HIV testing history and HIV-test result follow-up among female sex workers in two cities in Yunnan, China. *Sex Transm Dis* 2011; **38:** 89–95.

52 Jin X, Chan S, Ding G, Wang H, et al. Prevalence and risk behaviours for *Chlamydia trachomatis* and *Neisseria gonorrhoeae* infection among female sex workers in an HIV/AIDS high-risk area. *Internat J STD AIDS* 2011; **22:** 80–84.

53 Wang H, Brown KS, Wang G, et al. Knowledge of hiv seropositivity is a predictor for initiation of illicit drug use: incidence of drug use initiation among female sex workers in a high HIV-prevalence area of China. *Drug Alcohol Depend* 2011; **117:** 226–32.

54 Li Y, Detels R, Lin P, et al. Prevalence of HIV and STIs and associated risk factors among female sex workers in Guangdong Province, China (Special Issue: China meets new AIDS challenges). *J Acquir Immune Defic Syndr* 2010; **53** (suppl 1)**:** S48–53.

55 Hong H, Xu G, Zhang D. Long-term follow-up of a comprehensive HIV and sexually transmitted infection prevention program for female sex workers in Ningbo, China. *Int J Gynaecol Obstet* 2010; **111:** 180–81.

56 Xu J, Wang H, Jiang Y, et al. Application of the BED capture enzyme immunoassay for HIV incidence estimation among female sex workers in Kaiyuan City, China, 2006-2007. *Int J Infect Dis* 2010; **14:** e608–12.

57 Li N, Wang Z, Sun D, et al. HIV among plasma donors and other high-risk groups in Henan, China. *J Acquir Immune Defic Syndr* 2010; **53** (suppl 1)**:** S41–47.

58 Li Y, Lin P, Detels R, et al. Prevalence of HIV infection and sexually transmitted diseases and associated risk factors among female sex workers in Guangdong province. *Dis Surveill* 2009; **24:** 599–602.

59 Lu F, Jia Y, Sun X, Wang L, et al. Prevalence of HIV infection and predictors for syphilis infection among female sex workers in Southern China. *Southeast Asian J Trop Med Public Health* 2009; **40:** 263–72.

60 Wang H, Chen RY, Ding G, et al. Prevalence and predictors of HIV infection among female sex workers in Kaiyuan City, Yunnan Province, China. *Int J Infect Dis* 2009; **13:** 162–69.

61 Xu J, Wang N, Lu L, et al. HIV and STIs in clients and female sex workers in mining regions of Gejiu City, China. *Sex Transm Dis* 2008; **35:** 558–65.

62 Lau JTF, Tsui HY, Ho SPY. Variations in condom use by locale: a comparison of mobile Chinese female sex workers in Hong Kong and Mainland China. *Arch Sex Behav* 2007; **36:** 849–59.

63 Shethwala ND, Mulla SA, Kosambiya JK, Desai VK. Sexually transmitted infections and reproductive tract infections in female sex workers. *Indian J Pathol Microbiol* 2009; **52:** 198–99.

64 Mehendale SM, Gupte N, Paranjape RS, Brahme RG, Kohli R. Declining HIV incidence among patients attending sexually transmitted infection clinics in Pune, India. *J Acquir Immune Defic Syndr* 2007; **45:** 564–69.

65 Wayal S, Cowan F, Warner P, Copas A, Mabey D, Shahmanesh M. Contraceptive practices, sexual and reproductive health needs of HIV-positive and negative female sex workers in Goa, India. *Sex Transm Infect* 2011; **87:** 58–64.

66 Shahmanesh M, Cowan F, Wayal S, Copas A, Patel V, Mabey D. The burden and determinants of HIV and sexually transmitted infections in a population-based sample of female sex workers in Goa, India. *Sexually Trans Infect* 2009; **85:** 50–59.

67 Sarkar K, Bal B, Mukherjee R, et al. Sex-trafficking, violence, negotiating skill, and HIV infection in brothel-based sex workers of eastern India, adjoining Nepal, Bhutan, and Bangladesh. *J Health Popul Nutr* 2008; **26:** 223–31.

68 Ramesh BM, Moses S, Washington R, et al. Determinants of HIV prevalence among female sex workers in four south Indian states: analysis of cross-sectional surveys in twenty-three districts (special issue: characterizing the Indian HIV epidemic and assessing large-scale prevention efforts—Avahan.). *AIDS* 2008; **22** (suppl 5)**:** S35–S44.

69 Talsania NJ, Rathod D, Shah R, Patel Y, Mathur N. STI/HIV prevalence in Sakhi Swasthya Abhiyan, Jyotisangh, Ahmedabad: a clinico-epidemiological study. *Indian J Sex Transm Dis* 2007; **28:** 15–18.

70 Silitonga N, Davies SC, Kaldor J, Wignall S, Okoseray M. Prevalence over time and risk factors for sexually transmissible infections among newly-arrived female sex workers in Timika, Indonesia. *Sex Health* 2011; **8:** 61–64.

71 Magnani R, Riono P, Nurhayati, et al. Sexual risk behaviours, HIV and other sexually transmitted infections among female sex workers in Indonesia. *Sex Transm Infect* 2010; **86:** 393–99.

72 Center for HIV/AIDS/STI Lao. Integrated behavioral biological surveillance, Laos. Vientiane: Family Health International, 2009.

73 Malaysian AIDS Council. Malaysia Integrated Bio-Behavioural Surveillance (IBBS) Survey. Kuala Lumpur: Malaysian AIDS Council, 2009.

74 Davaalkham J, Unenchimeg P, Baigalmaa C, et al. High-risk status of HIV-1 infection in the very low epidemic country, Mongolia, 2007. *Int J STD AIDS* 2009; **20:** 391–94.

75 Hagan JE, Dulmaa N. Risk factors and prevalence of HIV and sexually transmitted infections among low-income female commercial sex workers in Mongolia. *Sex Transm Dis* 2007; **34:** 83–87.

76 Enkhbold S, Tugsdelger S, Morita S, Sakamoto J, Hamajima N. HIV/AIDS related knowledge and risk behaviors among female sex workers in two major cities of Mongolia. *Nagoya J Med Sci* 2007; **69:** 157–65.

77 Silverman JG, Dekcer MR, Gupta J, Maheshwari A, Willis BM, Raj A. HIV prevalence and predictors of infection in sex-trafficked Nepalese girls and women. *JAMA* 2007; **298:** 536–42.

78 National Centre for AIDS and STD Control (NCASC). Integrated biological and behavioral surveillance survey among female sex workers in Kathmandu valley: round III. Kathmandu: Ministry of Health and Population, 2008.

79 Control N-NCfAaS. Integrated biological and behavioral surveillance survey among female sex workers Pokhara Valley: round III. Kathmandu: Family Health International, 2008.

80 Hawkes S, Collumbien M, Platt L, et al. HIV and other sexually transmitted infections among men, transgenders and women selling sex in two cities in Pakistan: a cross-sectional prevalence survey. *Sex Transm Infect* 2009; **85** (suppl 2)**:** ii8–16.

81 Bokhari A, Nizamani NM, Jackson DJ, et al. HIV risk in Karachi and Lahore, Pakistan: an emerging epidemic in injecting and commercial sex networks. *Int J STD AIDS* 2007; **18:** 486–92.

82 National AIDS Control Program. HIV second generation

surveillance in Pakistan: national report round II. Islamabad: 2008.
83 Bruce E, Bauai L, Masta A, et al. Effects of periodic presumptive treatment on three bacterial sexually transmissible infections and HIV among female sex workers in Port Moresby, Papua New Guinea. *Sex Health* 2011; **8:** 222–28.
84 Bruce E, Bauai L, Yeka W, et al. Knowledge, attitudes, practices and behaviour of female sex workers in Port Moresby, Papua New Guinea. *Sex Health* 2010; **7:** 85–86.
85 Nhurod P, Bollen LJM, Smutraprapoot P, et al. Access to HIV testing for sex workers in Bangkok, Thailand: a high prevalence of HIV among street-based sex workers. *Southeast Asian J Trop Med Pub Health* 2010; **41:** 153–62.
86 Tuan NA, Fylkesnes K, Thang BD, et al. Human immunodeficiency virus (HIV) infection patterns and risk behaviours in different population groups and provinces in Viet Nam. *Bull World Health Organ* 2007; **85:** 35–41.
87 Vu Thuong N, Van Nghia K, Phuc Hau T, et al. Impact of a community sexually transmitted infection/HIV intervention project on female sex workers in five border provinces of Vietnam. *Sex Transm Infect* 2007; **83:** 376–82.
88 Nguyen TV, Van Khuu N, Truong PH, Nguyen AP, Truong LXT, Detels R. Correlation between HIV and sexual behavior, drug use, trichomoniasis and candidiasis among female sex workers in a Mekong Delta Province of Vietnam. *AIDS Behav* 2009; **13:** 873–80.
89 Qyra S, Basho M, Bani R, et al. Behavioral risk factors and prevalence of HIV and other STIs among female sex workers in Tirana, Albania. *New Microbiol* 2011; **34:** 105–08.
90 Uuskula A, Fischer K, Raudne R, et al. A study on HIV and hepatitis C virus among commercial sex workers in Tallinn. *Sex Transm Infect* 2008; **84:** 189–91.
91 Uuskula A, Johnston LG, Raag M, Trummal A, Talu A, Jarlais DC. Evaluating recruitment among female sex workers and injecting drug users at risk for HIV using respondent-driven sampling in Estonia. *Bull N Y Acad Med* 2010; **87:** 304–17.
92 Dershem L, Tabatadze M, Tsereteli N, Tsagareli T, Tsereteli T. Characteristics, high-risk behaviors and knowledge of STI/HIV/AIDS, and STI/HIV prevalence of facility-based female sex workers in Batumi, Georgia: 2004–2006. Report on two behavioral surveillance surveys with a biomarker component for the SHIP Project. Tbilisi, Georgia: Save the Children, 2007.
93 International HIV/AIDS Alliance. Behavioral monitoring and HIV infection prevalence among female sex workers as a component of second generation surveillance. Kyiv: Ukrainian AIDS Center, 2010.
94 Bautista CT, Pando MA, Reynaga E, et al. Sexual practices, drug use behaviors, and prevalence of HIV, syphilis, hepatitis B and C, and HTLV-1/2 in immigrant and non-immigrant female sex workers in Argentina. *J Immigrant Minority Health* 2009; **11:** 99–104.
95 Schuelter-Trevisol F, Da Silva MV, Oliveira CM, Rodrigues R. HIV genotyping among female sex workers in the State of Santa Catarina. *Rev Soc Bras Med Trop* 2007; **40:** 259–63.
96 Barrientos JE, Bozon M, Ortiz E, Arredondo A. HIV prevalence, AIDS knowledge, and condom use among female sex workers in Santiago, Chile. *Cad Saude Publica* 2007; **23:** 1777–84.
97 Lahuerta M, Sabido M, Giardina F, et al. Comparison of users of an HIV/syphilis screening community-based mobile van and traditional voluntary counselling and testing sites in Guatemala. *Sex Transm Infect* 2011; **87:** 136–40.
98 Soto RJ, Ghee AE, Nuñez CA, et al. Sentinel surveillance of sexually transmitted infections/HIV and risk behaviors in vulnerable populations in 5 Central American countries. *J Acquir Immune Defic Syndr* 2007; **46:** 101–11.
99 Persaud N, Cox F, Noble C, Bullen-McKenzie M, Obiero W. Behavioral surveillance survey/Guyana: out-of-school youth, in-school youth, female sex workers, men who have sex with men, employees of the sugar industry and members of the uniformed Services. Georgetown: Ministry of Health, 2008.
100 Duncan J, Gebre Y, Grant Y, et al. HIV prevalence and related behaviors among sex workers in Jamaica. *Sex Transm Dis* 2010; **37:** 306–10.
101 Strathdee SA, Lozada R, Martinez G, et al. Social and structural factors associated with HIV infection among female sex workers who inject drugs in the Mexico-US border region. *PLoS One* 2011; **6:** e19048.
102 Loza O. Factors associated with early initiation into sex work and sexually transmitted infections among female sex workers in two Mexico-U.S. border cities. San Diego: ProQuest Information & Learning, 2010.
103 Ulibarri MD, Strathdee SA, Ulloa EC, et al. Injection drug use as a mediator between client-perpetrated abuse and HIV status among female sex workers in two Mexico-US border cities. *AIDS Behav* 2011; **15:** 179–85.
104 Rusch MLA, Brouwer KC, Lozada R, Strathdee SA, Magis-Rodriguez C, Patterson TL. Distribution of sexually transmitted diseases and risk factors by work locations among female sex workers in Tijuana, Mexico. *Sexually Transm Dis* 2010; **37:** 608–14.
105 Sirotin N, Strathdee SA, Lozada R, et al. A comparison of registered and unregistered female sex workers in Tijuana, Mexico. *Public Health Rep* 2010; **125** (suppl 4)**:** 101–09.
106 Ojeda VD, Strathdee SA, Lozada R, et al. Associations between migrant status and sexually transmitted infections among female sex workers in Tijuana, Mexico. *Sex Transm Infect* 2009; **85:** 420–26.
107 Patterson TL, Semple SJ, Staines H, et al. Prevalence and correlates of HIV infection among female sex workers in 2 Mexico-US border cities. *J Infect Dis* 2008; **197:** 728–32.
108 Aguayo N, LagunaTorres VA, Villafane M, et al. Epidemiological and molecular characteristics of HIV-1 infection among female commercial sex workers, men who have sex with men and people living with AIDS in Paraguay. *Rev Soc Bras Med Trop* 2008; **41:** 225–31.
109 Ministry of Health and Population NAP. HIV/AIDS biological & behavioral surveillance survey. Cairo, Egypt: Family Health International, 2007.
110 Mahfoud Z, Afifi R, Ramia S, et al. HIV/AIDS among female sex workers, injecting drug users and men who have sex with men in Lebanon: results of the first biobehavioral surveys. *AIDS* 2010; **24** (suppl 2)**:** S45–S54.
111 Kriitmaa K, Testa A, Osman M, et al. HIV prevalence and characteristics of sex work among female sex workers in Hargeisa, Somaliland, Somalia (special issue: progress in HIV research in the Middle East and North Africa: new study methods, results, and implications for prevention and care). *AIDS* 2010; **24** (suppl 2)**:** S61–S67.
112 Abdelrahim MS. HIV prevalence and risk behaviors of female sex workers in Khartoum, north Sudan (special issue: progress in HIV research in the Middle East and North Africa: new study methods, results, and implications for prevention and care). *AIDS* 2010; **24** (suppl 2)**:** S55–S60.
113 Znazen A, Frikha-Gargouri O, Berrajah L, et al. Sexually transmitted infections among female sex workers in Tunisia: high prevalence of *Chlamydia trachomatis*. *Sex Transm Infect* 2010; **86:** 500–05.
114 Lajoie J, Massinga Loembe M, Poudrier J, et al. Blood soluble human leukocyte antigen G levels are associated with human immunodeficiency virus type 1 infection in Beninese commercial sex workers. *Human Immunol* 2010; **71:** 182–85.
115 Ahoyo AB, Alary M, Méda H, et al. Enquête de surveillance intégrée du VIH et des autres infections sexuellement transmissibles chez les travailleuses du sexe au Bénin en 2002. *Cahiers d'Études et de recherche francophone/Santé* 2007; **17:** 143–51.
116 Mosoko JJ, Macauley IB, Zoungkanyi AC, Bella A, Koulla-Shiro S. Human immunodeficiency virus infection and associated factors among specific population subgroups in Cameroon. *AIDS Behav* 2009; **13:** 277–87.
117 Dada Y, Milord F, Frost E, et al. The Indian Ocean paradox revisited: HIV and sexually transmitted infections in the Comoros. *Int J STD AIDS* 2007; **18:** 596–600.
118 Family Health International. Integrated Biological and Behavioural Surveillance Survey. Nigeria: Nigerian Federal Ministry of Health, 2008.
119 Mwandagalirwa K, Jackson EF, McClamroch K, Bollinger R, Ryder RW, Weir SS. Local differences in human immunodeficiency virus prevalence: a comparison of social venue patrons, antenatal patients, and sexually transmitted infection patients in eastern Kinshasa. *Sexually Transm Dis* 2009; **36:** 406–12.
120 Vandepitte JM, Malele F, Kivuvu D-M, et al. HIV and other sexually transmitted infections among female sex workers in Kinshasa, Democratic Republic of Congo, in 2002. *Sex Trans Dis* 2007;

34: 203–08.

121 Gupta SB, Murphy G, Koenig E, et al. Comparison of methods to detect recent HIV type 1 infection in cross-sectionally collected specimens from a cohort of female sex workers in the Dominican Republic. *AIDS Res Hum Retroviruses* 2007; **23:** 1475–80.

122 Diallo BL, Alary M, Barry A, Rashed S. HIV epidemic among female sex workers in Guinea: prevalence, associated risk factors, vulnerability and trend from 2001 to 2007. *Rev Epidemiol Sante Publique* 2010; **58:** 245–54.

123 McClelland RS, Richardson BA, Wanje GH, et al. Association between participant self-report and biological outcomes used to measure sexual risk behavior in human immunodeficiency virus-1-seropositive female sex workers in Mombasa, Kenya. *Sex Transm Dis* 2011; **38:** 429–33.

124 Luchters SM, Vanden Broeck D, Chersich MF, et al. Association of HIV infection with distribution and viral load of HPV types in Kenya: a survey with 820 female sex workers. *BMC Infect Dis* 2010; **10:** 18.

125 Tovanabutra S, Sanders EJ, Graham SM, et al. Evaluation of HIV type 1 strains in men having sex with men and in female sex workers in Mombasa, Kenya. *AIDS Res Hum Retroviruses* 2010; **26:** 123–31.

126 Elst EMvd, Okuku HS, Nakamya P, et al. Is audio computer-assisted self-interview (ACASI) useful in risk behaviour assessment of female and male sex workers, Mombasa, Kenya? *PLoS One* 2009; **4:** e5340.

127 Kimani J, Kaul R, Nagelkerke NJD, et al. Reduced rates of HIV acquisition during unprotected sex by Kenyan female sex workers predating population declines in HIV prevalence. *AIDS* 2008; **22:** 131–37.

128 Luchters S, Chersich MF, Rinyiru A, et al. Impact of five years of peer-mediated interventions on sexual behavior and sexually transmitted infections among female sex workers in Mombasa, Kenya. *BMC Public Health* 2008; **8:** 143.

129 Hirbod T, Kaul R, Reichard C, et al. HIV-neutralizing immunoglobulin A and HIV-specific proliferation are independently associated with reduced HIV acquisition in Kenyan sex workers. *AIDS* 2008; **22:** 727–35.

130 Lacap PA, Huntington JD, Luo M, et al. Associations of human leukocyte antigen DRB with resistance or susceptibility to HIV-1 infection in the Pumwani sex worker cohort. *AIDS* 2008; **22:** 1029–38.

131 Chersich MF, Luchters SMF, Malonza IM, Mwarogo P, King'ola N, Temmerman M. Heavy episodic drinking among Kenyan female sex workers is associated with unsafe sex, sexual violence and sexually transmitted infections. *Int J STD AIDS* 2007; **18:** 764–69.

132 Harijaona V, Ramambason JD, Morisset R, Rasamindrakotroka A, Ravaoarinoro M. Prevalence of and risk factors for sexually-transmitted infections in hidden female sex workers. *Med Mal Infect* 2009; **39:** 909–13.

133 Malawi NACo. Biological and behavioral surveillance survey. Lilongwe: Family Health International, 2007.

134 Mauritius AIDS Unit. Integrated behavioral and biological surveillance survey among female sex workers, 2010. http://www.gov.mu/portal/goc/moh/file/ibbs.pdf (accessed March 6, 2012).

135 Sule WF, Adewumi MO, Samuel TC. Human immunodeficiency virus (HIV) specific antibodies among married pregnant women and female commercial sex workers attending voluntary counseling and HIV testing (VCT) centre in Abuja, Nigeria. *African J Biotechnol* 2009; **8:** 941–48.

136 Imade G, Sagay A, Egah D, et al. Prevalence of HIV and other sexually transmissible infections in relation to lemon or lime juice douching among female sex workers in Jos, Nigeria. *Sex Health* 2008; **5:** 55–60.

137 Braunstein SL, Ingabire CM, Kestelyn E, et al. High human immunodeficiency virus incidence in a cohort of Rwandan female sex workers. *Sex Transm Dis* 2011; **38:** 385–94.

138 Toure Kane C, Diawara S, Ndiaye HD, et al. Concentrated and linked epidemics of both HSV-2 and HIV-1/HIV-2 infections in Senegal: public health impacts of the spread of HIV. *Int J STD AIDS* 2009; **20:** 793–96.

139 Wang C, Hawes SE, Gaye A, et al. HIV prevalence, previous HIV testing, and condom use with clients and regular partners among Senegalese commercial sex workers. *Sex Transm Infect* 2007; **83:** 534–40.

140 van Loggerenberg F, Mlisana K, Williamson C, et al. Establishing a Cohort at High Risk of HIV infection in South Africa: challenges and experiences of the CAPRISA 002 acute infection study. *PLoS One* 2008; **3:** e1954.

141 Sobela F, Pepin J, Gbeleou S, et al. A tale of two countries: HIV among core groups in Togo. *J Acquir Immune Defic Syndr* 2009; **51:** 216–23.

142 Vandepitte J, Bukenya J, Weiss HA, et al. HIV and other sexually transmitted infections in a cohort of women involved in high-risk sexual behavior in Kampala, Uganda. *Sex Transm Dis* 2011; **38:** 316–23.

143 Cowan FM, Pascoe SJ, Barlow KL, et al. A randomised placebo-controlled trial to explore the effect of suppressive therapy with acyclovir on genital shedding of HIV-1 and herpes simplex virus type 2 among Zimbabwean sex workers. *Sex Transm Infect* 2008; **84:** 548–53.

144 Ainsworth M, Beyrer C, Soucat A. AIDS and public policy: the lessons and challenges of "success" in Thailand. *Health Policy* 2003; **64:** 13–37.

145 Celentano DD, Nelson KE, Lyles CM, et al. Decreasing incidence of HIV and sexually transmitted diseases in young Thai men: evidence for success of the HIV/AIDS control and prevention program. *AIDS* 1998; **12:** F29–36.

146 Rojanapithayakorn W, Hanenberg R. The 100% condom program in Thailand. *AIDS* 1996; **10:** 1–7.

147 Laga M, Galavotti C, Sundararaman S, Moodie R. The importance of sex-worker interventions: the case of Avahan in India. *Sex Transm Infect* 2010; **86** (suppl 1)**:** i6–7.

148 Swendeman D, Ishika B, Sankari D, Smarajit J, RotheramBorus MJ. Empowering sex workers in India to reduce vulnerability to HIV and sexually transmitted diseases. *Soc Sci Med* 2009; **69:** 1157–66.

149 Caceres CF. HIV among gay and other men who have sex with men in Latin America and the Caribbean: a hidden epidemic? *AIDS* 2002; **16:** S23–33.

150 Ditmore M, Allman D. Implications of PEPFAR's anti-prostitution pledge for HIV prevention among organizations working with sex workers. *HIV AIDS Policy Law Rev* 2010; **15:** 63–64.

151 Masenior NF, Beyrer C. The US anti-prostitution pledge: first amendment challenges and public health priorities. *PLoS Med* 2007; **4:** e207.

152 Kerrigan D, Telles P, Torres H, Overs C, Castle C. Community development and HIV/STI-related vulnerability among female sex workers in Rio de Janeiro, Brazil. *Health Educ Res* 2008; **23:** 137–45.

153 UNAIDS, WHO. Guidelines for second generation HIV surveillance. Geneva: World Health Organization, 2000.

154 Stover J, Bertozzi S, Gutierrez JP, et al. The global impact of scaling up HIV/AIDS prevention programs in low- and middle-income countries. *Science* 2006; **311:** 1474–76.

155 The National AIDS and STIs Control Programme. National guidelines for HIV/STI programs for sex workers. Nairobi, Kenya: Ministry of Public Health and Sanitation, 2010.

156 The National AIDS and STIs Control Programme. Kenya national AIDS strategic plan 2010–2013—delivering on universal access to services. Nairobi, Kenya: Office of the President, 2009.

157 Supervie V, Halima Y, Blower S. Assessing the impact of mass rape on the incidence of HIV in conflict-affected countries. *AIDS* 2010; **24:** 2841–47.

158 Schwartlander B, Stover J, Hallett T, et al. Towards an improved investment approach for an effective response to HIV/AIDS. *Lancet* 2011; **377:** 2031–41.

159 Chohan V, Baeten JM, Benki S, et al. A prospective study of risk factors for herpes simplex virus type 2 acquisition among high-risk HIV-1 seronegative women in Kenya. *Sex Transm Infect* 2009; **85:** 489–92.

160 Brahmam GN, Kodavalla V, Rajkumar H, et al. Sexual practices, HIV and sexually transmitted infections among self-identified men who have sex with men in four high HIV prevalence states of India. *AIDS* 2008; **22** (suppl 5)**:** S45–57.

161 Kang D, Liao M, Jiang Z, et al. Commercial sex venues, syphilis and methamphetamine use among female sex workers. *AIDS Care* 2011; **23:** 26–36.

162 The World Bank. Gross national income per capita 2008, Atlas method and PPP. Geneva: The World Bank, 2009.

163 Cohen MS, Chen YQ, McCauley M, et al. Prevention of HIV-1 infection with early antiretroviral therapy. *N Engl J Med* 2011; **365:** 493–505.